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A new troglobitic species of *Allochthonius* (subgenus *Urochthonius*) (Pseudoscorpiones, Pseudotyrannochthoniidae) from Japan

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Abstract

Allochthonius (*Urochthonius*) *yoshizawai* **sp. nov.**, found in Hiura-do Cave, a limestone cave located in the municipality of Kumakogen, Ehime Prefecture, Japan, is described. It can be distinguished from the consubgeneric species mainly by the carapacal chaetotaxy (6–2, 18), by the presence of 6 setae on the cheliceral palm, by the rallum with 11 blades, by the presence of 8 clavate coxal blades on coxae I, and by the decreased number and distinct shape of the chelal teeth. A redescription of the subgenus *Urochthonius*, and keys to the subgenera of *Allochthonius* and to the species and subspecies of *Urochthonius* are also provided, as well as some ecological remarks, a brief discussion on troglomorphisms for the subgenus, and potential threats for this species.

Keywords

Cave, pseudoscorpions, taxonomy, troglomorphism

Introduction

In East Asia, the pseudoscorpion family Pseudotyrannochthoniidae Beier, 1932 is represented by two genera, *Allochthonius* Chamberlin, 1929 and *Pseudotyrannochthonius* Beier, 1930 (Harvey 2013). The genus *Allochthonius* is further divided into two

subgenera: *Allochthonius* Morikawa, 1954, composed of 16 species (Hu and Zhang 2012; Gao and Zhang 2013; Harvey 2013; Zhang and Zhang 2014; Gao et al. 2016), and *Urochthonius* Morikawa, 1954, with three species (Hu and Zhang 2012; Harvey 2013). The subgenus *Allochthonius* is characterized by four-eyed, mostly surface-living species, whereas anophthalmic or two-eyed, mostly cave-dwelling species, are allocated to the subgenus *Urochthonius* (Morikawa, 1960).

During an expedition to caves in Japan (carried out from September 5 to 15, 2017), a single pseudoscorpion was found, belonging to a new species herein described. The single male specimen belonging to the subgenus *Urochthonius* was found in Hiura-do Cave, a limestone cave located in Shikoku Island. The new species is considered troglobitic, and it shows a distinct combination of morphological features. It shares some characteristics with two consubgeneric species, *A.* (*U.*) *ishikawai* Morikawa, 1954 and *A.* (*U.*) *brevitus* Hu & Zhang, 2012.

It is important to point out that the subgeneric division of the genus *Allochthonius*, which is solely based on morphological characters (e.g. the absence or number of eyes) and typical habitat type, appears unstable and thus a taxonomic revision is imperative. However, while we recognize the need of further research on this matter, the description of a new species based on a single specimen, although oftentimes discouraged by researchers, can be of crucial importance, especially when taken into consideration species conservation. Furthermore, it is noteworthy that many troglobitic species, especially predators, can be extremely rare. Due to impacts on cave systems, a species may lose its habitat and become potentially extinct before its formal taxonomic description, as observed by Ferreira et. al. (2020). Accordingly, we hereby propose the description of a newly discovered *Urochthonius* species.

Methods

Study area

Fieldwork was carried out in September 2017 at Hiura-do Cave, a limestone cave located in the municipality of Kumakogen, Ehime Prefecture, Shikoku Island, Japan (Figs 1, 5A–D). A visual search was conducted, and a single male specimen was found walking on a rock wall. It was captured by using a fine brush, and subsequently transferred to a small-labeled plastic vial containing 70% ethanol for preservation.

More details on habitat are covered in a separate section (habitat and threats) later in the paper.

Preparation and analysis

In order to properly observe taxonomic characters, the specimen and its dissected appendages were mounted in temporary cavity slides, using glycerin as medium. Photographs and measurements of body parts were taken with a Zeiss Axio Zoom.V16 stereomicroscope, using the software Zen 2.3. Drawings were prepared with a draw-

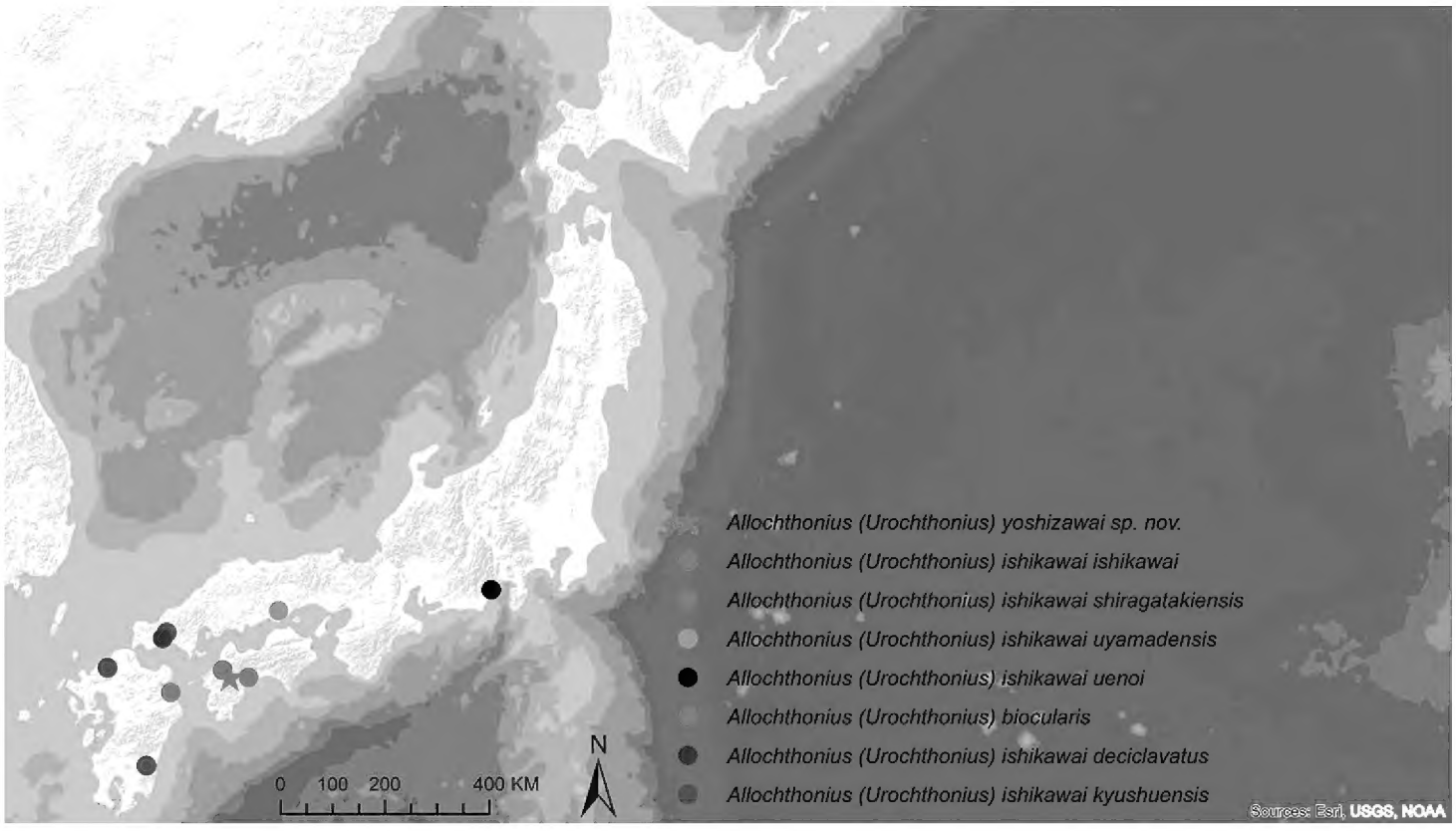

Figure 1. Map of distribution of the representatives of the subgenus *Urochthonius* in Japan.

ing tube on a Leica DM750 microscope equipped with phase contrast. For drawings, Kaiser's glycerol gelatin was used instead of glycerin. This mounting media solidifies at cold temperatures, thus allowing the dissected body parts to be kept in a fixed position.

Description of coloration was based on photographs of the living specimen, which were taken with a Cannon SX50 camera. The terminology used in the description follows Chamberlin (1931), Harvey (1992), Judson (2007), Vachon (1941a, 1941b) and Gabbutt and Vachon (1963). Measurements follow Chamberlin (1931) and represent the average of two measurements taken on different days.

Abbreviations used: For trichobothria: ***ib*** = interior basal; ***isb*** = interior sub-basal; ***ist*** = interior sub-terminal; ***it*** = interior terminal; ***eb*** = exterior basal; ***esb*** = exterior sub-basal; ***est*** = exterior sub-terminal; ***et*** = exterior terminal; ***b*** = basal; ***sb*** = sub-basal; ***st*** = sub-terminal; ***t*** = terminal. **ICHUM** = Invertebrate Collection of the Hokkaido University Museum; **ME** = main entrance, **SE** = secondary entrance.

Results

Family Pseudotyrannochthoniidae Beier, 1932
Genus *Allochthonius* Chamberlin, 1929
Subgenus *Urochthonius* Morikawa, 1954

Type species. *Allochthonius* (*Urochthonius*) *ishikawai* Morikawa, 1954.

Diagnosis (modified from Morikawa 1960). No eyes or, more rarely, two rudimentary eyes present. Epistomal process absent. Fixed chelal finger with 7–20 acute marginal teeth, movable finger with 10–17. Cheliceral palm with 5–6 setae; fixed fin-

ger of chelicera generally with one basal large tooth and a few small teeth before it, with one distal large tooth and several teeth after it, or with several small teeth on the median swelling without any large tooth. Coxal blades of coxa I with a spray of 5–11 clavate processes on a mound. Palps, chelicerae and legs long and slender. Setae of the body also long and slender. Typically cave inhabitants.

Allochthonius (*Urochthonius*) *yoshizawai* sp. nov.

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Figures 2–4

Type material. Holotype male (ICHUM-6165), in alcohol: Japan, Ehime Prefecture, Kumakogen, Hiura-do Cave (33°29'20.4"N, 132°55'48.0"E), on the cave wall (dark zone), 5 September 2017, R.L. Ferreira leg.

Etymology. The specific name is given in honor of Dr. Kazunori Yoshizawa, not only due to the assistance provided during fieldwork in Japanese caves, but also to his great contribution to the knowledge of arthropods, especially Psocodea.

Diagnosis. Differing from the other members of subgenus *Urochthonius* by the following combination of characters: carapace with 18 setae (6 on anterior margin, 2 on posterior margin); cheliceral palm with 6 setae, fixed cheliceral finger with large basal tooth, rallum with 11 blades (each with fine barbules, the basal-most blade shorter than the others); coxa I with a spray of 8 clavate coxal blades (subequal in length) on a mound, bisetose intercoxal tubercle present between coxae III and IV; on the fixed chelal finger, 7 (8 on the right chela) acute, narrow, large, widely-spaced teeth; on the movable chelal finger, 10 acute, small, widely-spaced teeth; chelal teeth varying in size.

Description of adult male (female unknown). Troglomorphic habitus (Fig. 2A, B). Body mostly translucent, with a vitreous aspect. Chelae, chelicerae, and tergites light pinkish orange; other parts of body white. Vestitural setae smooth, long and acuminate.

Carapace (Fig. 4B): Nearly square in dorsal outline, 1.1 times longer than broad, slightly constricted posteriorly; anterior margin somewhat straight, but becoming indistinctly concave towards median region; without eyes or eyespots; two weak transverse furrows present, near anterior and posterior margins; chaetotaxy 6: 6: 2: 2: 2 (18).

Figure 2. *Allochthonius* (*U.*) *yoshizawai* sp. nov., male holotype **A** habitus of male **B** live specimen in natural habitat. Scale bar: 2 mm (**A**).

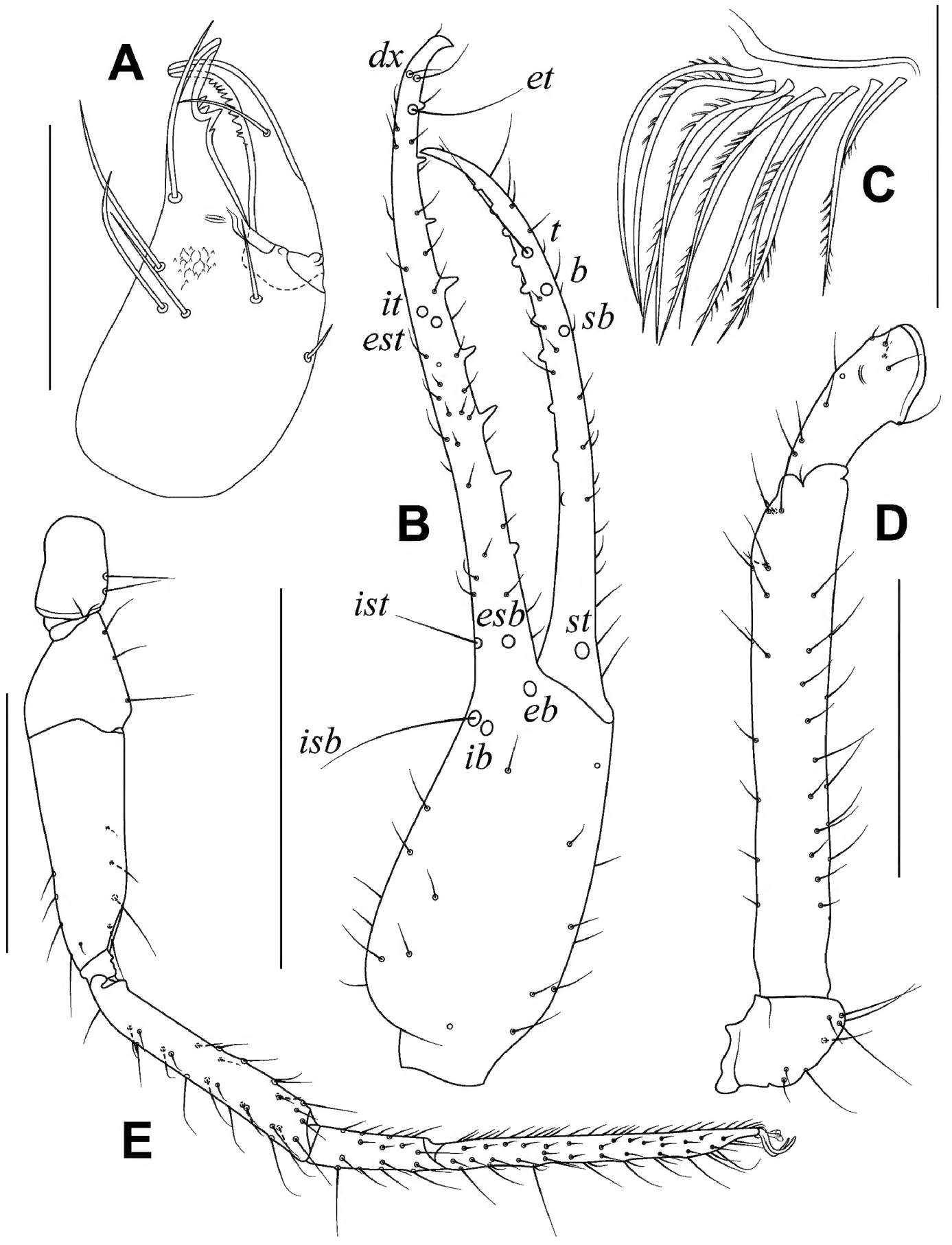

Figure 3. *Allochthonius* (*U.*) *yoshizawai* sp. nov., male holotype **A** right chelicera, showing detail of surface texture, antiaxial (slightly ventral) view **B** right chela, showing trichobothrial pattern and marginal teeth, antiaxial view **C** right cheliceral rallum **D** left palp, dorsal view **E** left leg IV, retrolateral view. Scale bars: 0.25 mm (**A**); 0.5 mm (**B**, **D**, **E**); 0.125 mm (**C**).

Chelicerae (Fig. 3A, C): Surface mostly scaly-reticulate. Hand with 6 setae (including 1 ventral seta); movable finger with 1 subdistal seta; galea absent; fixed finger with 4 apical teeth, including one large basal tooth (third one on right chelicera, fourth

one on left), followed by small denticles (4–12); movable finger with 6–8 teeth of equal length, followed by 7 smaller teeth on left chelicera (a few denticles on right chelicera); rallum (Fig. 3C) composed of 11 blades (7 in one row, 4 in another row) with fine barbules, the basal-most one distinctly shorter than the others (~1/3 length of other blades); serrula exterior with 18 blades, serrula interior of the left chelicera with 15 blades, 16 blades on the right.

Tergites: Undivided; chaetotaxy uniseriate, I–XI 2: 2: 4: 6: 6: 7: 9: 10: 8: 5: 2. Anal operculum without dorsal setae.

Coxae: Palpal: manducatory process with two setae, apical seta reduced; rest of palpal coxae with three setae. Pedal: coxae I each with a spray of 8 clavate blades (Fig. 4D); chaetotaxy I 4, II 4–5, III 5, IV 5–6; intercoxal tubercle present between coxae III and IV, bearing two setae.

Genital operculum of male (Fig. 4A, C): Anterior genital operculum with 6 anterior setae, and one posterior seta; genital opening with 8 setae on the right side, and 10 on the left.

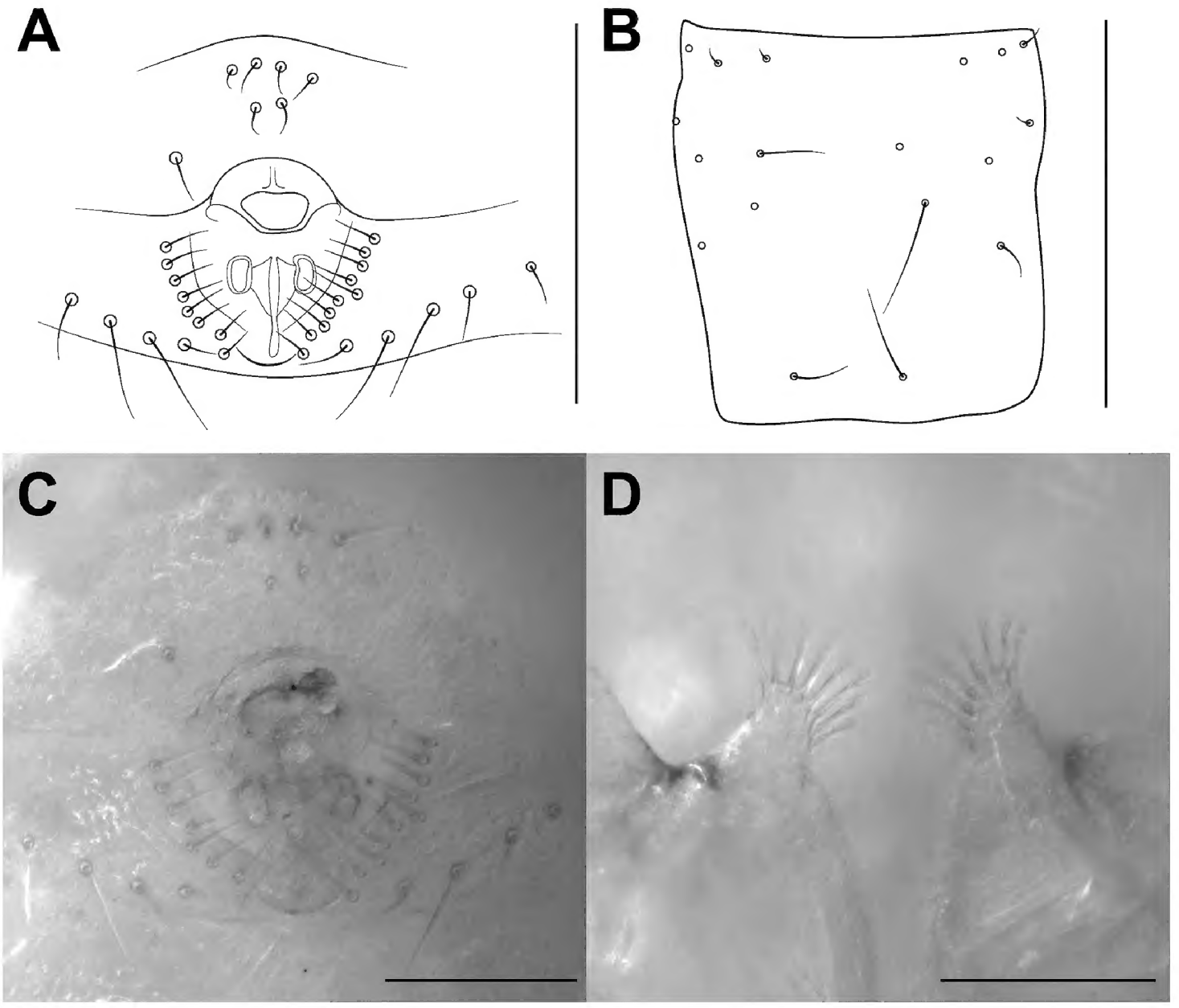

Figure 4. *Allochthonius* (*U.*) *yoshizawai* sp. nov., male holotype. **A** Male genital operculum **B** holotype carapace, showing distribution of setae (most hairs missing) **C** male genital operculum **D** coxal blades on coxae I, ventral view. Scales: 0.25 mm (**A**); 0.5 mm (**B**); 0.1 mm (**C**, **D**).

Sternites: Chaetotaxy II–XI 13: 16: 17: 15: 15: 15: 12: 10:–:2. Anal operculum with one pair of ventral setae.

Palp (Fig. 3B, D): Femur chaetotaxy: 6: 10: 4: 7: 2 (Fig. 3D). Trichobothria *ib* and *isb* located on a small dorsal hump. Trichobothrial pattern (Fig. 3B): trichobothrium *sb* distinctly nearer *b* than *sb*; *it* distad to *est*; trichobothria *ib-isb-eb-esb-ist* clustered at the base of fixed finger. On the left chela trichobothrium *est* is missing. Fingers distinctly curved, movable finger shorter than fixed finger. Fixed finger with 7 (8 on the right chela) acute, large, narrow, widely-spaced, irregular marginal teeth; on the left chela, the fourth distal tooth distinctly larger than the others, two small basal tubercles present; the right fixed finger marginal teeth larger compared with those of the left chela. Movable finger with 10 acute, small, widely-spaced, irregular teeth.

Leg IV (Fig. 3E): Subterminal setae long and acuminate. Arolia shorter than claws, latter slender and smooth. Two tactile setae present, one on the metatarsus and another on the tarsus.

Measurements (length/breadth or, for legs, length/depth in mm, ratios in parentheses): Body length 1.97. Carapace 0.55/0.51 (1.1). Palps: trochanter 0.29/0.16 (1.8), femur 0.91/0.14 (6.5), patella 0.31/0.13 (2.5), hand with pedicel 0.54/0.26 (2.0), movable finger length 0.78, chela with pedicel 1.39 (5.3). Leg I: femur 0.53/0.08 (6.4), patella 0.32/0.07 (4.8), femur/patella (1.6), tibia 0.26/0.06 (4.7), tarsus 0.56/0.06 (10.2). Leg IV: femur+patella 0.77/0.17 (4.4), tibia 0.57/0.09 (6.1), metatarsus 0.28/0.07 (3.8), tarsus 0.64/0.06 (11.5), tarsus/metatarsus (2.3).

Key to subgenera of *Allochthonius*[*]

1 Four eyes well-developed, mostly free-living species....**Subgenus *Allochthonius***

– Eyes completely absent or two rudimentary eyes, mostly cave-dwelling species..... **Subgenus *Urochthonius***

Key to species and subspecies of *Urochthonius*

1 Two rudimentary eyes present.....***A.* (*U.*) *biocularis***

– Eyes absent **2**

2 Palpal femur stout, 3.9 times longer than broad.....***A.* (*U.*) *brevitus***

– Palpal femur slender, 3.9–6.5 times longer than broad.....**3**

3 Cheliceral palm with 6 setae, rallum with 11 blades .....
.....***A.* (*U.*) *yoshizawai* sp. nov.**

– Cheliceral palm with 5 setae, rallum with 10 blades.....**4**

4 Chelal fingers distinctly curved, fixed finger with 9 marginal teeth, movable finger with 11 marginal teeth.....***A.* (*U.*) *ishikawai shiragatakiensis***

– Fixed chelal fingers not so curved, with 13–17 marginal teeth **5**

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* modified from Morikawa 1960.

5	Anterior margin of carapace with 10 setae..... **6**
–	Anterior margin of carapace with 8 setae..... 7
6	Chelal fingers with 13–14 marginal teeth; cheliceral movable finger with about 13 minute teeth ..... ***A. (U.) ishikawai deciclavatus***
–	Chelal fingers with about 16 marginal teeth; cheliceral movable finger with about 18 minute teeth ..... ***A. (U.) ishikawai kyushuensis***
7	Body length 1.51–1.97 mm..... ***A. (U.) ishikawai ishikawai***
–	Body length 2.31–2.38 mm..... **8**
8	Carapace chaetotaxy 8–2, 24 ..... ***A. (U.) ishikawai uenoi***
–	Carapace chaetotaxy 8–2, 18 ..... ***A. (U.) ishikawai uyamadensis***

Habitat and threats

Hiura-do Cave is a limestone cave with approximately 160 meters of horizontal extent and two entrances (Fig. 5B). The secondary entrance (Fig. 5B, SE), although wider than the main entrance (Fig. 5B, ME), is considerably low (<1 m in height), in addition to being located on a rock escarpment, which makes access to the cave interior quite difficult. From the main entrance (Fig. 5A), the conduit presents a descending slope, until reaching a vertical pit, from which is possible to access a lower level. At the deepest part of the cave there is a drainage (Fig. 5D), which springs at the end of the cave and sinks a few meters further. This drainage springs out at the external environment some dozen meters down from the main cave entrance, forming a stream. Most of the cave conduits are formed by exposed limestone, being devoid of sediments (Fig. 5C). The single specimen of *A. (U.) yoshizawai* sp. nov. was found freely walking on a limestone surface, on the side of the wall, actively crawling in an aphotic area located around 50 meters from the nearest entrance (Fig. 5B). The cave is highly oligotrophic, and only some scarce organic debris deriving from vegetation was observed when it was visited. Neither bat colonies nor guano deposits were observed. Nonetheless, it is important to point out that there may be seasonal variation (i.e. the influx of organic matter may be higher during certain periods of the year).

Potential prey for the pseudoscorpion are mainly springtails (Entomobryomorpha and Onychiuridae), which are relatively abundant in the cave. Other troglobitic species observed in the cave during our visit included, besides the Collembola, the highly troglomorphic carabid beetle *Nipponaphaenops erraticus* Ueno, 1971, the staphylinid beetle *Quedius* sp., the Grylloblattodea *Galloisiana* (an undescribed species), and a Rhagidiidae mite.

The cave presents obvious signs of human visitation (there is an iron ladder installed from the upper to the lower level), but such visitors seem to be mostly speleologists, so no severe impacts were observed in the cave. The external environment is also well preserved, with a forest covering most of the landscape. Considering the well-preserved status of both the cave and the external landscape surrounding the cave, the species seems not to be seriously threatened at the moment.

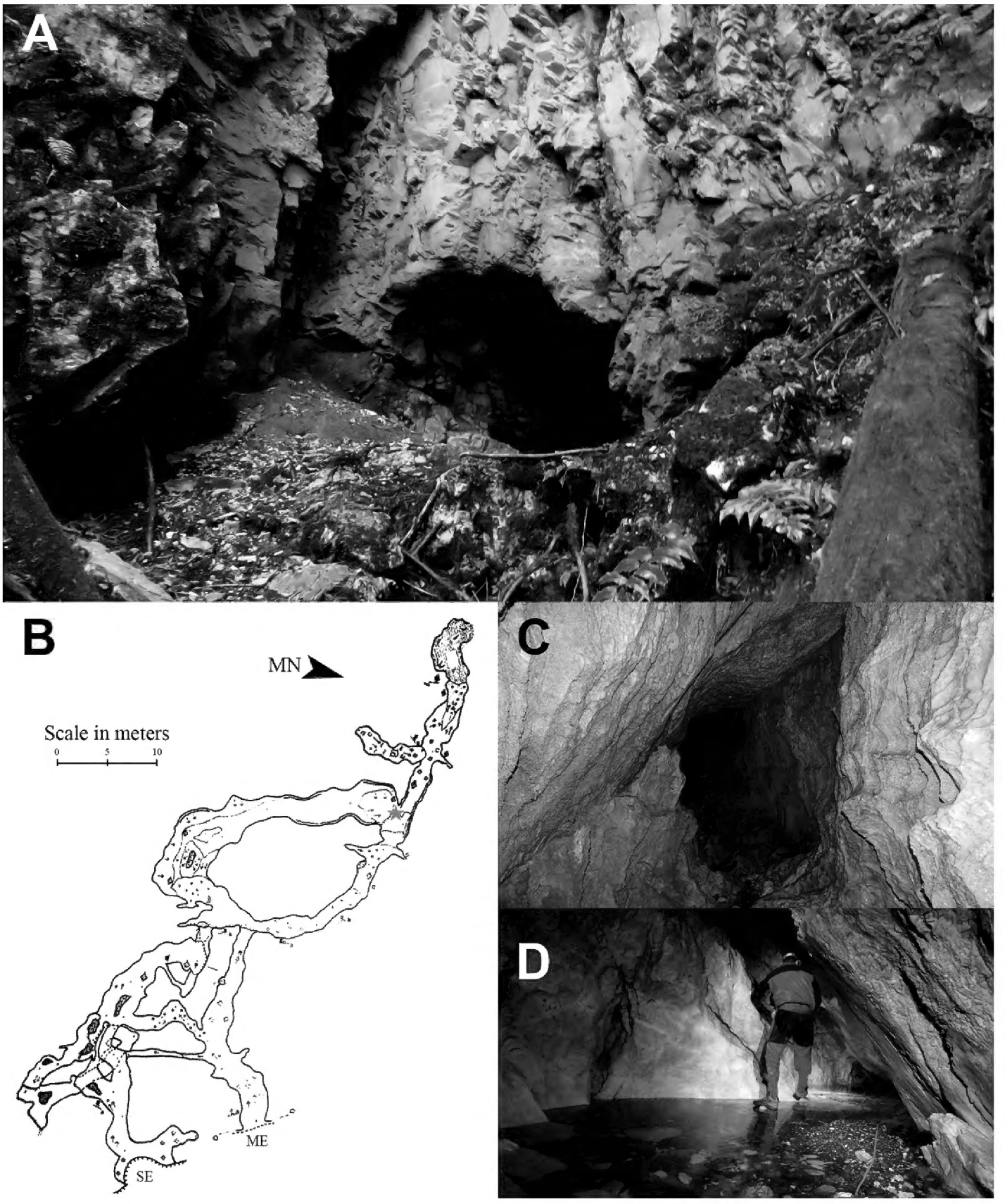

Figure 5. Type locality and habitat of *Allochthonius* (*U.*) *yoshizawai* sp. nov. **A** Main cave entrance **B** map of Hiura-do Cave, showing the site (red star) where the specimen was found, as well as the entrances **C** general aspect of the cave conduit. The specimen was collected crawling on a damp wall **D** drainage system at the deepest portion of the cave.

Discussion

Troglomorphisms and taxonomic traits

Concerning *Urochthonius* spp., it is difficult to state with certainty whether some characteristics represent typical troglomorphisms found in other pseudoscorpions. Two spe-

cies, *A.* (*U.*) *biocularis* Morikawa, 1956 and *A.* (*U.*) *ishikawai*, are cave-dwelling, found in Japan. One of the main differences regarding external morphology between *A.* (*U.*) *biocularis* and *A.* (*U.*) *ishikawai* is that the former bears two anterior rudimentary eyes (Morikawa 1956), whereas the latter is anophthalmic (Morikawa 1954, 1956, 1960). The only epigean species within the subgenus, *A.* (*U.*) *brevitus*, which is recorded from China, is also characterized by the absence of eyes (Hu and Zhang 2012; Zhang and Zhang 2014). Contrastingly, the cave-dwelling representative of the nominal subgenus from Japan, *A.* (*A.*) *opticus troglophilus* Morikawa, 1956, bears four eyes on the carapace – the main diagnostic character for the subgenus (Morikawa 1960). It is clear, therefore, that the genus *Allochthonius* should undergo a major taxonomic revision, including phylogenetic analyses and thorough examination of type material, not only for providing a better understanding of troglomorphisms in the group, but also for assessing the validity of the subgenera (which could eventually be synonymized). In conclusion, the lack of phylogenetic studies precludes any tests whether the absence of eyes represents a morphological specialization to the subterranean environment within the genus.

Nonetheless, *A.* (*U.*) *brevitus* exhibits an array of characteristics that sets it apart from the hypogean species. *Allochthonius* (*U.*) *brevitus* is characterized by having generally stouter appendages. Particularly in reference to its palpal femur ratio (3.9 times longer than broad) (Hu and Zhang 2012; Zhang and Zhang 2014), it is significantly smaller when taken into account the range shown by the consubgeneric species (5.1–6.5 times longer than broad) (Morikawa 1954, 1956, 1960). Additionally, in terms of coloration, the body is mostly light yellowish (except for the carapace and tergites, which are strong yellowish brown), and the chelicerae and palps are reddish (Hu and Zhang 2012; Zhang and Zhang 2014). On the other hand, cave-dwelling *Urochthonius* species show a pronounced reduction in body color as can be inferred from the descriptions of *A.* (*U.*) *ishikawai uenoi* Morikawa, 1956, *A.* (*U.*) *biocularis*, and *A.* (*U.*) *ishikawai ishikawai* Morikawa, 1954 (Morikawa 1954, 1956). Paleness and more elongate, slender appendages represent common troglomorphic traits found in pseudoscorpions (Heurtault 1994). Therefore, we argue that the aforementioned characters could be pointed out as the main morphological specializations presented by cavernicolous *Urochthonius* species.

Furthermore, although it may simply represent a dispersal-aiding trait, the considerably high level of chelal finger curvature could potentially represent a troglomorphism for the cave-dwelling species in the subgenus. When comparing the chelal fingers of hypogean species and the single epigean representative, *A.* (*U.*) *brevitus*, the former present generally curved fingers (Morikawa 1954, 1956, 1960), whereas the latter shows straight fingers, only slightly curved distally (Hu and Zhang 2012; Zhang and Zhang 2014). This higher curvature (see in Figure 2B the wide gap between the curved fingers of the chelae, especially in the right chela) may enable the troglobitic species to capture both bigger and smaller prey. When considering the usually low population densities of cave invertebrates in general, such a trait could be adaptive, allowing them to feed on a wider range of potential prey, which may be important in an oligotrophic environment.

We note some inconsistencies in the measurements and ratios in the descriptions of *A.* (*U.*) *biocularis* and *A.* (*U.*) *ishikawai kyushuensis* Morikawa, 1960, regarding the palpal femur (Morikawa 1956, 1960). In reference to *A.* (*U.*) *biocularis*, a range of 5.3–5.7 times longer than broad is mentioned, but measurements are only specified for the holotype (Morikawa 1956). Concerning *A.* (*U.*) *ishikawai kyushuensis*, the values for length and breadth provided for the palpal femur of the holotype are, respectively, 1.13 mm and 0.07 mm. Comparing to the dimensions given for the remaining types (female allotype, 1.29/0.20; male paratype, 1.02/0.18; female paratype, 1.35/0.22), a breadth of 0.07 mm appears to be considerably narrow. Additionally, the ratios that can be obtained by using the previous values, which make up a range of 5.7–16.1 times longer than broad, are different from those found in the description: "*palpal femur 5.7–6.7 times* (*in male*) *and 6.1–7.5 times* (*in female*)" (Morikawa 1960). Furthermore, concerning leg I, except for *A.* (*U.*) *brevitus*, no values for length and breadth or ratios can be found in the descriptions of *Urochthonius* species. Also, only the descriptions of *A.* (*U.*)*ishikawai ishikawai*, *A.* (*U.*) *ishikawai uyamadensis* Morikawa, 1954 and *A.* (*U.*) *brevitus* include measurement data for leg IV. Hence, we opted for not comparing dimensions extensively between *Urochthonius* species and subspecies.

Allochthonius (*U.*) *yoshizawai* sp. nov. is markedly pale, as evidenced by the mostly translucent cuticle of the holotype, and also presents slender appendages (e.g. palpal femur 6.5 times longer than broad). The new species presents a combination of characters based on which distinction from the consubgeneric species can be easily made. Differences related to the carapacal chaetotaxy, number of setae on the cheliceral palm, number of rallum blades, and number of palp chela marginal teeth can be indicated.

Carapacal chaetotaxy: Urochthonius species show a range of 18–28 setae on the carapace (Morikawa 1954, 1956, 1960; Hu and Zhang 2012). In the new species, a total of 18 carapacal setae (6 on anterior margin, 2 on posterior margin) can be found. *Allochthonius* (*U.*) *ishikawai uyamadensis* exhibits the same number of setae on the carapace, however, differently from *A.* (*U.*) *yoshizawai* sp. nov., it has 8 setae on the anterior margin (Morikawa 1954).

Cheliceral traits: Allochthonius (*U.*) *brevitus* has 6 setae on the cheliceral palm (Hu and Zhang 2012), as with the new species. Contrastingly, all *A.* (*U.*) *ishikawai* subspecies have 5 setae on the cheliceral palm (Morikawa 1954, 1956, 1960). In *A.* (*U.*) *ishikawai* subspecies, the rallum includes 10 pinnate blades (Morikawa 1954, 1956, 1960); in *A.* (*U.*) *yoshizawai* sp. nov., there are 11 clavate blades on the rallum of the singular known specimen. *Allochthonius* (*U.*) *brevitus* shows the same number of rallum blades as the new species (Hu and Zhang 2012).

Number of chelal teeth: Allochthonius (*U.*) *ishikawai* subspecies have a range of 9–17 teeth on the fixed chelal finger, and 11–17 teeth on the movable finger (Morikawa 1954, 1956, 1960). Regarding *A.* (*U.*) *brevitus*, 20 teeth can be found on the fixed finger, 17 on the movable (Hu and Zhang 2012). Finally, the new species has 7 (8 on the right chela) teeth on the fixed finger, 10 on the movable. A similar number (fixed finger: 9, movable finger: 11) was identified in *A.* (*U.*) *ishikawai shiragatakiensis* Morikawa, 1954. Accordingly, both taxa bear less than half the number of teeth generally shown by the congeners.

On the troglobitic status of *Urochthonius* species

With regard to the subgenus *Urochthonius*, the troglobitic status of its representatives has not been considered in previous works. As outlined earlier, important morphological specializations to the subterranean environment (e.g. paleness) can be recognized in *Urochthonius* cavernicolous species. Hence, we argue that *A.* (*U.*) *yoshizawai* sp. nov. and the consubgeneric cave-dwellers are troglobitic.

Even when taking into account that *A.* (*U.*) *ishikawai kyushuensis* was recorded from six caves located in Kyushu and Honshu islands, inference of the troglobitic status for the subgenus as a whole is still plausible. Sendra et al. (2018) described a troglobitic species of campodeid dipluran collected from caves located in Shikoku and Kyushu islands. *Pacificampa nipponica* Sendra, 2018, was found in two caves, each one located in a different island. It is known that these islands, currently separate, used to be connected during the last glacial age (Sendra et al. 2018). In this regard, we can conclude that although a certain species inhabits more than one cave, even when distant from each other, it can still be assigned as troglobitic.

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References

Chamberlin JC (1931) The arachnid order Chelonethida. Stanford University Publications (Biological Sciences) 7(1): 1–284.

Ferreira RL, Oliveira MPA de, Souza-Silva M (2020) Biospeleology of the Lagoa Santa Karst. In Lagoa Santa Karst: Brazil's Iconic Karst Region. Springer, Cham, 187–208. https://doi.org/10.1007/978-3-030-35940-9_10

Gabbutt PD, Vachon M (1963) The external morphology and life history of the pseudoscorpion *Chthonius ischnocheles* (Hermann). Proceedings of the Zoological Society of London 140: 75–98. https://doi.org/10.1111/j.1469-7998.1963.tb01855.x

Gao Z, Zhang F (2013) Description of a new *Allochthonius* species from China, with a key to the genus (Pseudoscorpiones: Pseudotyrannochthoniidae). Entomologica Fennica 23: 107–112. https://doi.org/10.33338/ef.8346

Gao Z, Zhang Y, Zhang F (2016) Two new species of Pseudotyrannochthoniidae, including the first species of *Pseudotyrannochthonius* (Pseudoscorpiones) from China. Acta Zoologica Academiae Scientiarum Hungaricae 62(2): 117–131. https://doi.org/10.17109/AZH.62.2.117.2016

Harvey MS (1992) The phylogeny and classification of the Pseudoscorpionida (Chelicerata: Arachnida). Invertebrate Systematics 6: 1373–1435. https://doi.org/10.1071/IT9921373

Harvey MS (2013) Pseudoscorpions of the World. Version 3.0. Western Australian Museum, Perth. http://www.museum.wa.gov.au/catalogues-beta/pseudoscorpions [date of access: 30 September 2019]

Heurtault J (1994) Pseudoscorpions. In: Juberthie C, Decu V (Eds) Encyclopaedia Biospeologica (Vol. 1). Société de Biospéologie, Moulis and Bucharest, 437–442.

Hu JF, Zhang F (2012) Two new species of the genus *Allochthonius* Chamberlin from China (Pseudoscorpiones: Pseudotyrannochthoniidae). Entomologica Fennica 22: 243–248. https://doi.org/10.33338/ef.5003

Judson MLI (2007) A new and endangered species of the pseudoscorpion genus *Lagynochthonius* from a cave in Vietnam, with notes on chelal morphology and the composition of the Tyrannochthoniini (Arachnida, Chelonethi, Chthoniidae). Zootaxa 1627: 53–68. https://doi.org/10.11646/zootaxa.1627.1.4

Morikawa K (1954) On some pseudoscorpions in Japanese lime-grottoes. Memoirs of Ehime University (2B) 2: 79–87.

Morikawa K (1956) Cave pseudoscorpions of Japan (I). Memoirs of Ehime University (2B) 2: 271–282.

Morikawa K (1960) Systematic studies of Japanese pseudoscorpions. Memoirs of Ehime University (2B) 4: 85–172.

Sendra A, Yoshizawa K, Ferreira RL (2018) New oversize troglobitic species of Campodeidae in Japan (Diplura). Subterranean Biology 27: 53–73. https://doi.org/10.3897/subtbiol.27.28575

Vachon M (1941a) *Chthonius tetrachelatus* P. (Pseudoscorpions) et ses formes immatures (1re note). Bulletin du Muséum National d'Histoire Naturelle, Paris, Series 2 13: 442–449.

Vachon M (1941b) *Chthonius tetrachelatus* P. (Pseudoscorpions) et ses formes immatures (2e note). Bulletin du Muséum National d'Histoire Naturelle, Paris, Series 2 13: 540–547.

Zhang FB, Zhang F (2014) A new species of the genus *Allochthonius* (Pseudoscorpiones: Pseudotyrannochthoniidae) from Liupan mountains, China, with description of the male of *Allochthonius brevitus*. Acta Zoologica Academiae Scientiarum Hungaricae 60(1): 45–56.